Synthetic Vision Display Concepts (SVDC)

Dallas/Fort-Worth Flight Test

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Outline

- Test Objectives
- Displays and Experimental Hardware
- Test Maneuvers
- Data Collection Process
- Preliminary Findings
- Next Flight Test Plans
- Turn it over to Rockwell-Collins

Test Objectives

- Evaluate NASA concepts to address retrofit issues and explore display parameters
- Evaluate Rockwell-Collins head-down concept (aimed at near-term implementation using current avionics)

Display Parameters Evaluated

- Head-Up Display (HUD)
  - Terrain Database Texture: Generic, Photo-realistic
- Head-Down Display (HDD)
  - Size: A/B, D, X
  - Terrain Database Texture: Generic, Photo-realistic
  - Selectable Field of View (FOV)

HUD Concept

- Evaluate an *unconventional* use of a HUD for both VMC and IMC operations
  - Provide an *opaque,* computer-generated terrain scene, overlaid on the real world scene
  - Use declutter switch to view real world (when desired or at decision height)
  - Certification issues about obscuration of real world are a recognized concern
- Evaluate terrain texturing techniques
  - Generic vs. Photo-realistic

Generically-textured HUD

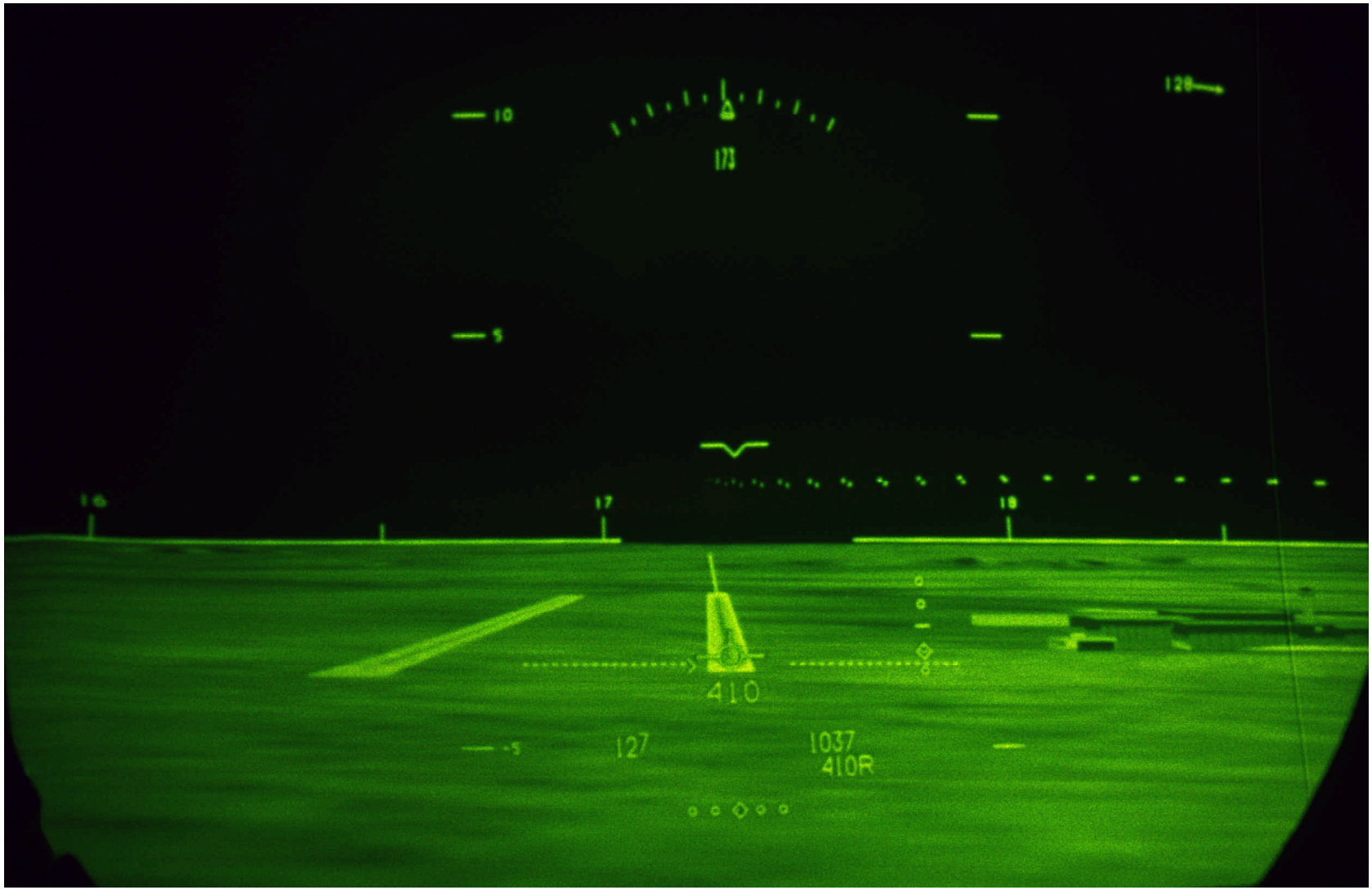
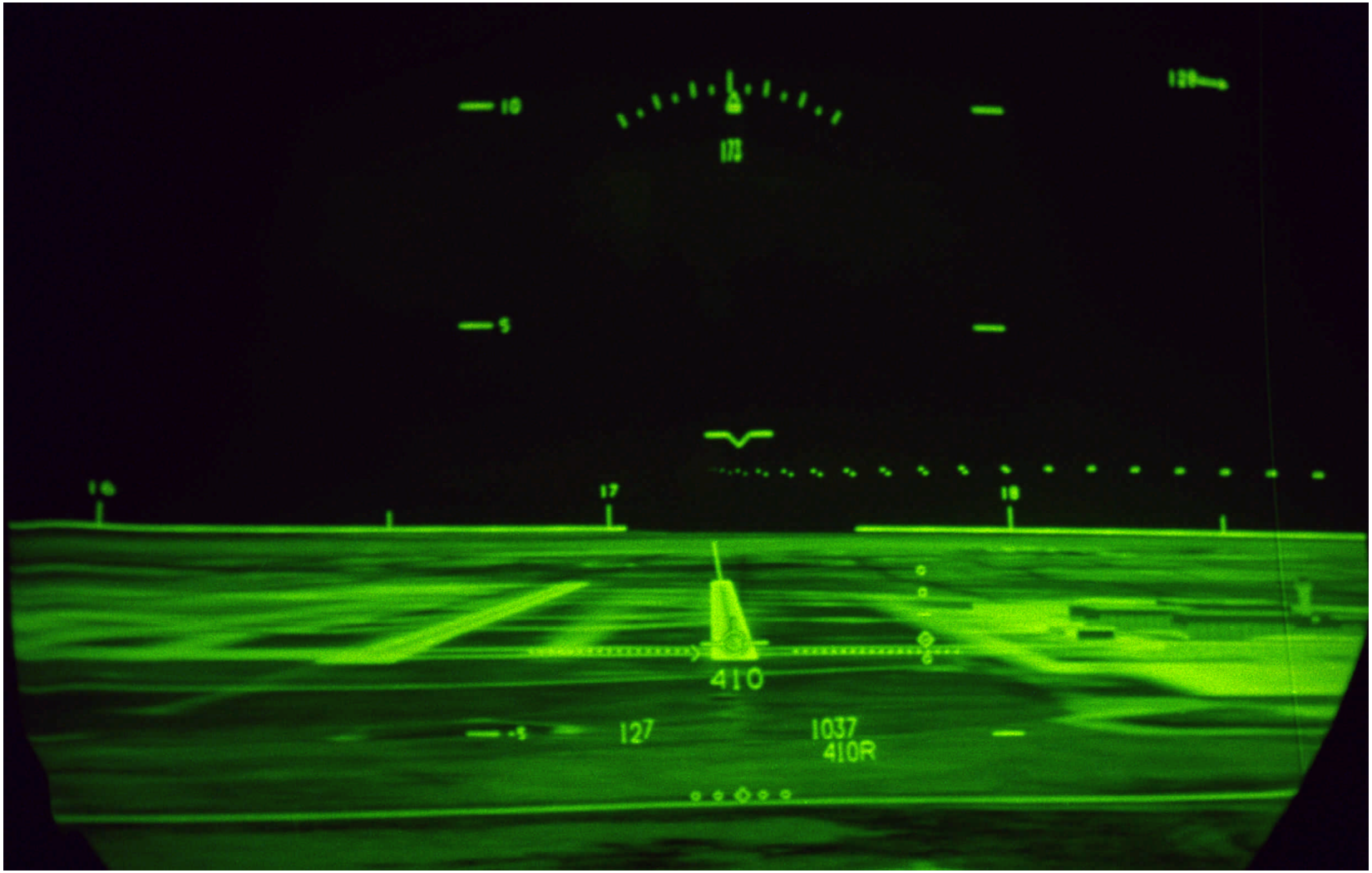


Photo-textured HUD

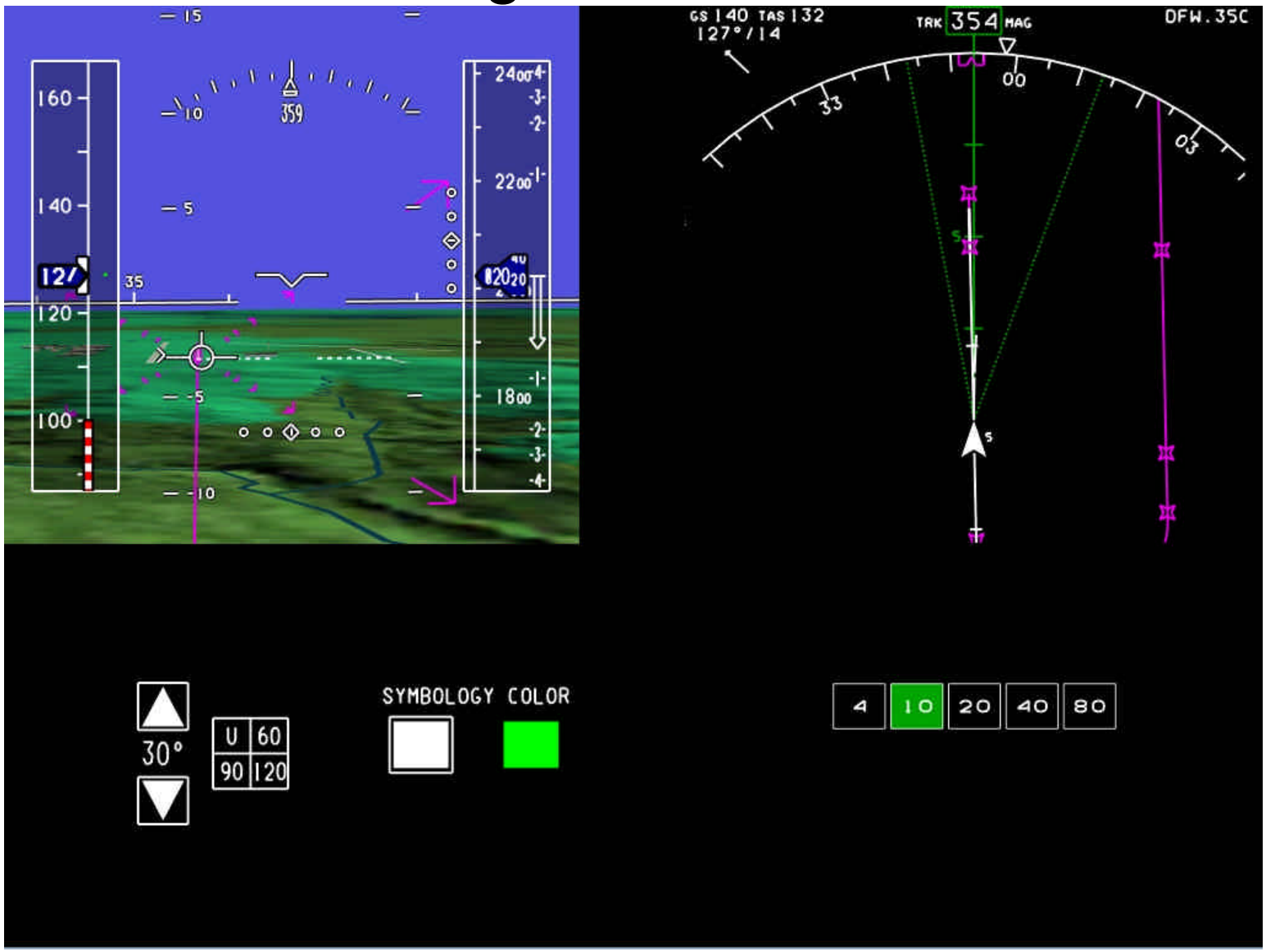


SVDC Experimental Hardware…

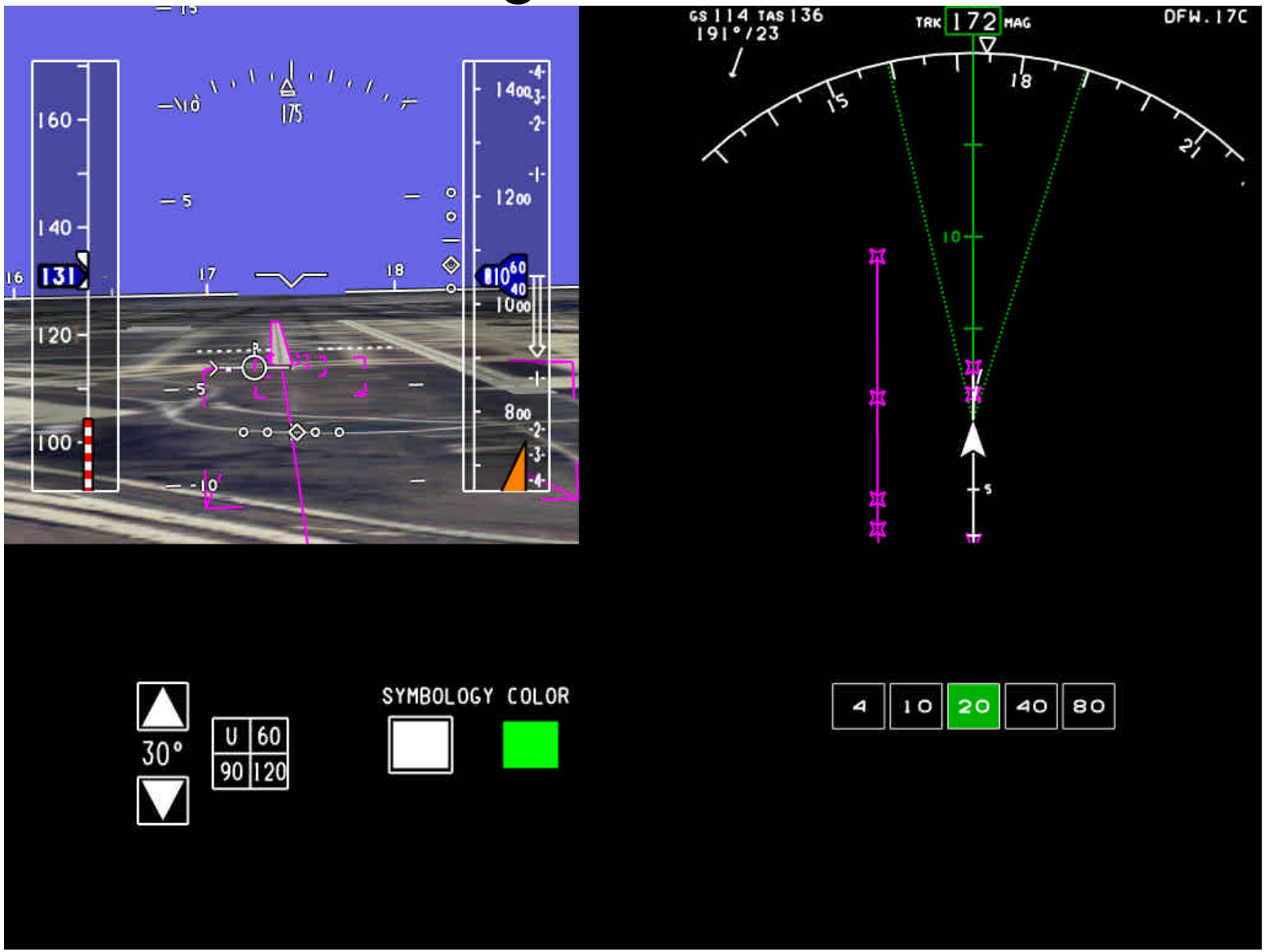
Retrofitting NASA's 757 for SVDC Research

- **SVS Research Display**
  - Large, 18.1" High-Brite LCD display with touchscreen and brightness control
  - Displays A/B, D, X formats
  - Capable of SXGA resolution
  - Designed for easy in-flight removal
- **SVS Graphics Engine**
  - 2 Intergraph Zx1 PCs
    - Dual 800-MHz Processors
    - 1 Gig of RAM
  - Wildcat 4110 Video board
    - 268 MB of Texture memory
  - For R/C work: included Obsidian-2
  - Provided capability to generate photo-realistic terrain – on HUD and HDD
  - **Less than $10,000 per PC!**

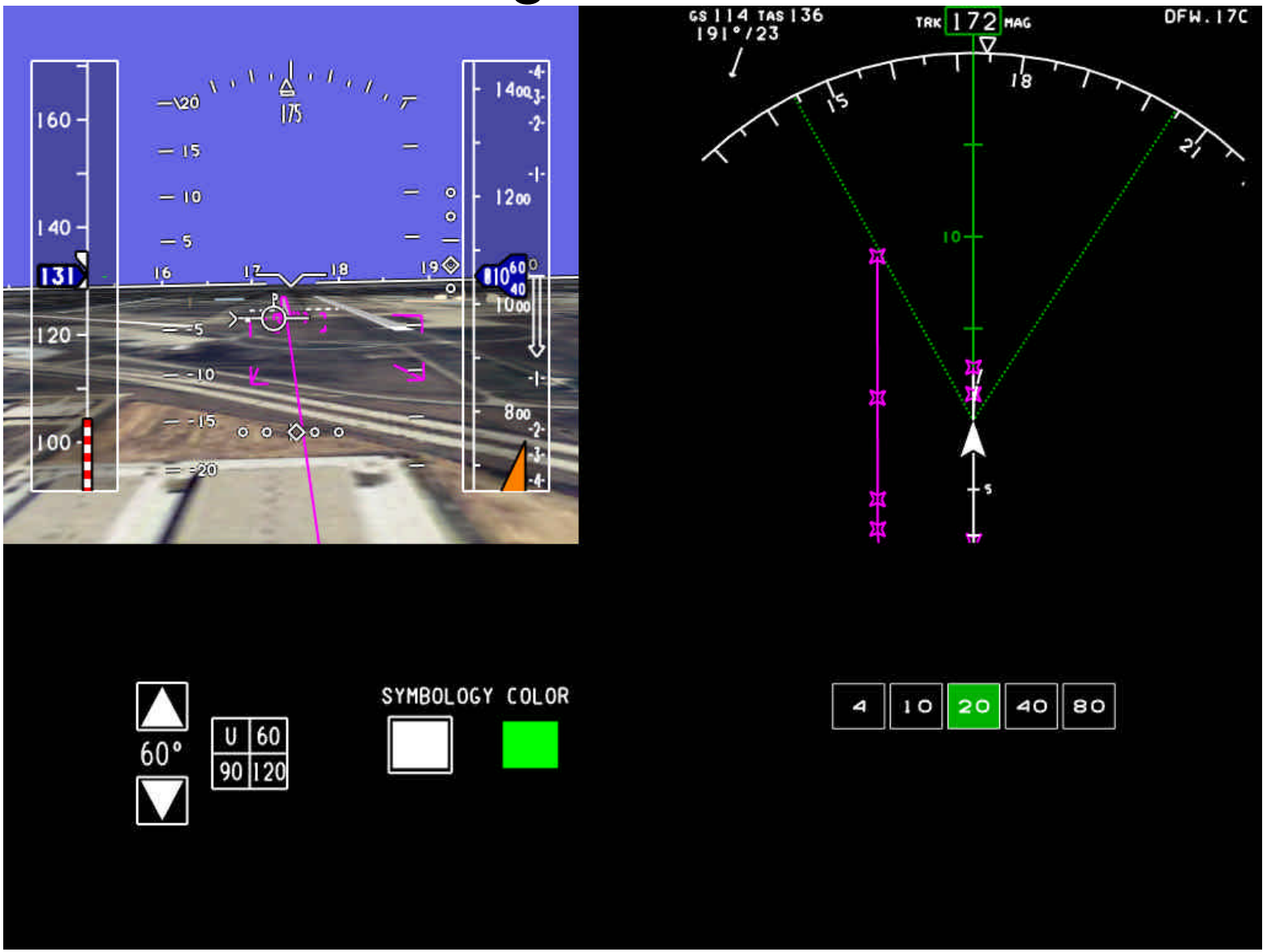
Size-D, 30 deg FOV, Generic-texture



Size-D, 30 deg FOV, Photo-texture

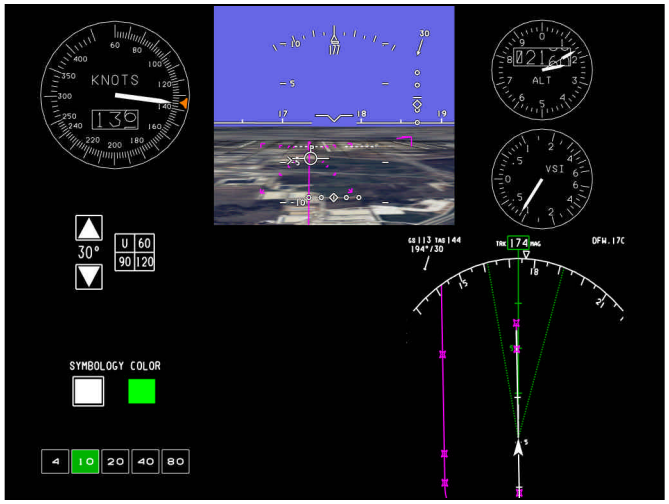


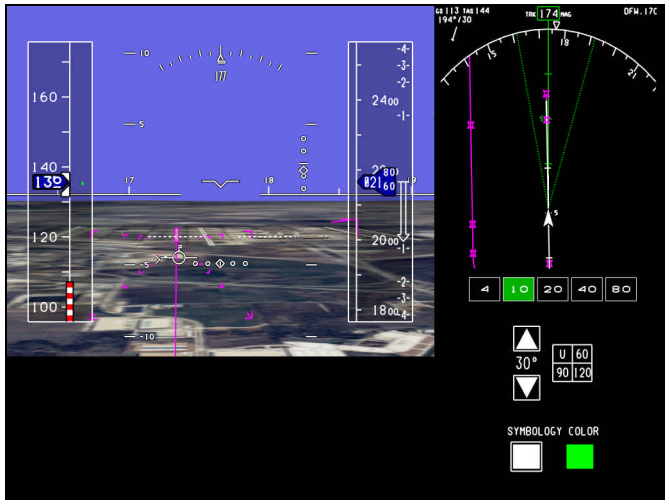
Size-D, 60 deg FOV, Photo-texture

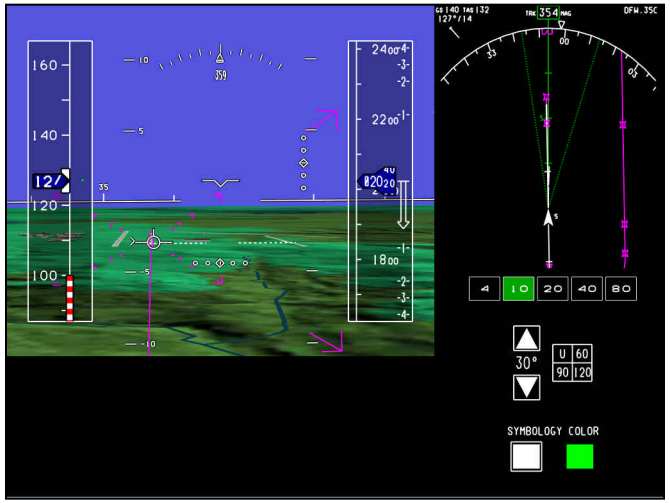


Size A/B and Size-X Concepts

Size A/B





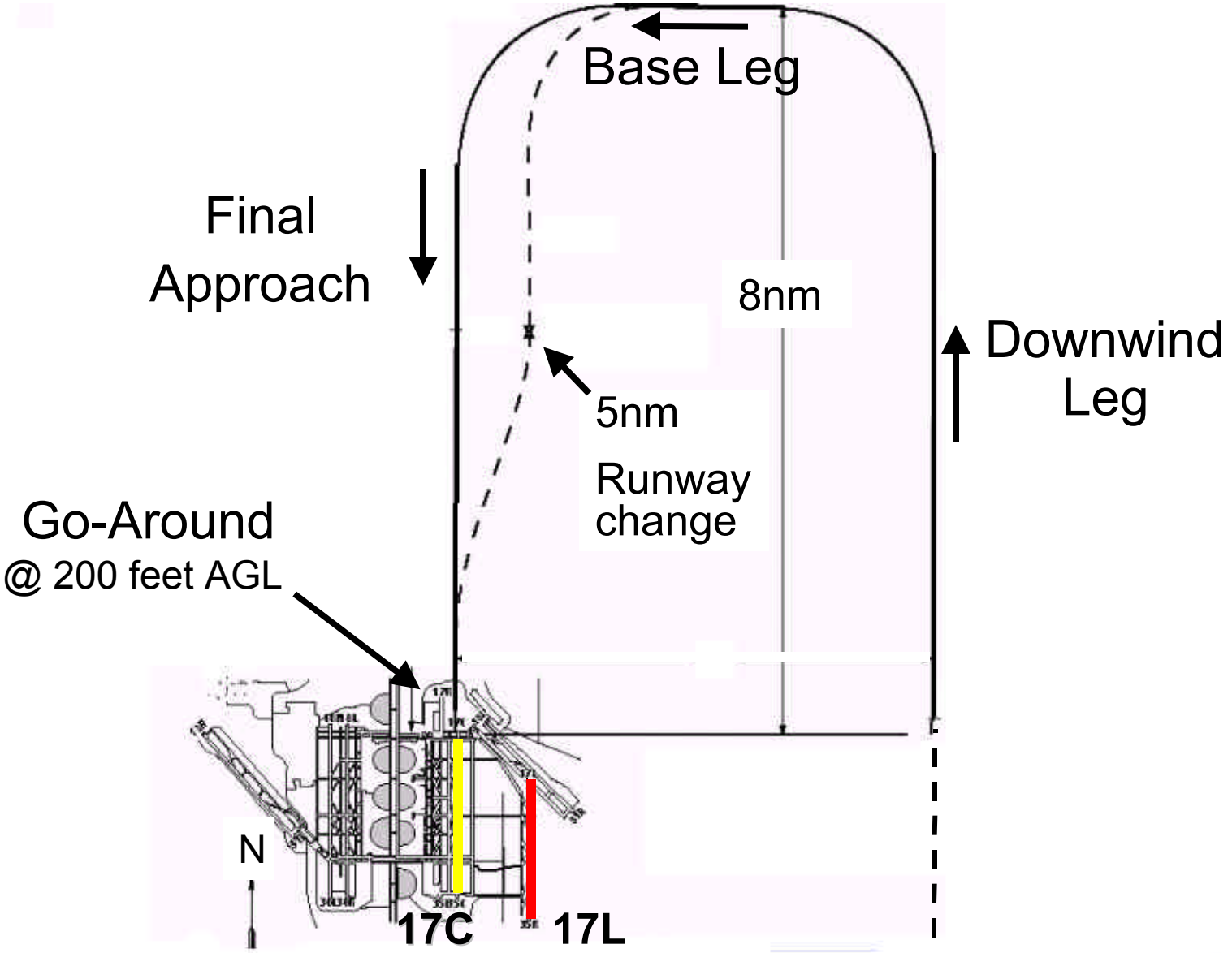


Size X

Flight Test Characteristics

- 6 Evaluation pilots
- 17.5 hours of research time
- 76 approaches
- Nominal approaches per pilot:
  - 4-HUD
  - 3-Rockwell-Collins HDD
  - 6-NASA HDD

NASA South-flow Evaluation Maneuvers



Data Collection

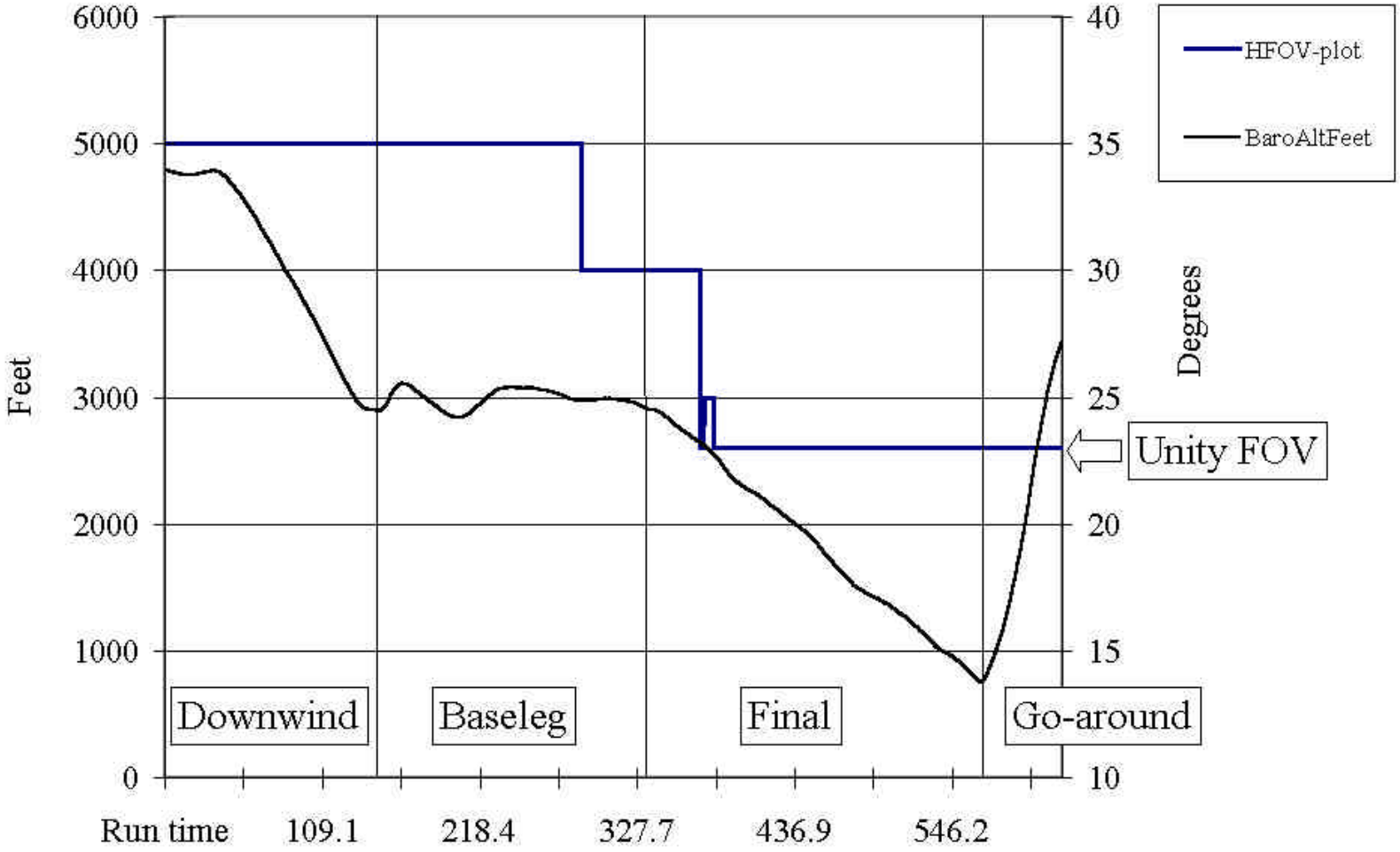
- Qualitative, Situational Awareness Measures
  - Post-run
    - Short questionnaire in-flight
    - Pilot comments were recorded on video tape
  - Post-flight
    - Full debriefs conducted
    - Detailed questionnaire
- Quantitative, Objective Data
  - FOV selections
  - Path control
  - Runway change task performance
    - Maximum bank angles
    - Altitude to re-establish on final approach
    - Heading control

Some Preliminary Findings

- Pilot comments: **Head-Up Display**
  - **Opaque terrain image on HUD was widely accepted for night operations**
  - Judging distance and closure rates seemed better with Photo-realistic terrain
  - Larger FOV of HUD and being head-up were positively reflected in pilot's comments when compared to HDDs
  - Collimation aspect of HUD enhanced 3-D effect of terrain image
- Pilot comments: **Head-Down Display**
  - Field Of View (FOV)
    - All pilots preferred using selectable FOVs
      - Larger FOVs prior to final (~60 degrees)
      - ~25-45 deg FOV for runway change
      - Smaller FOVs close-in on final approach (~30 deg or less)
  - Judging distance and closure rates seemed better with Photo-realistic terrain
  - Larger displays preferred over small

Example of FOV Data

Pilot #1, Generic Terrain, Size-X Display



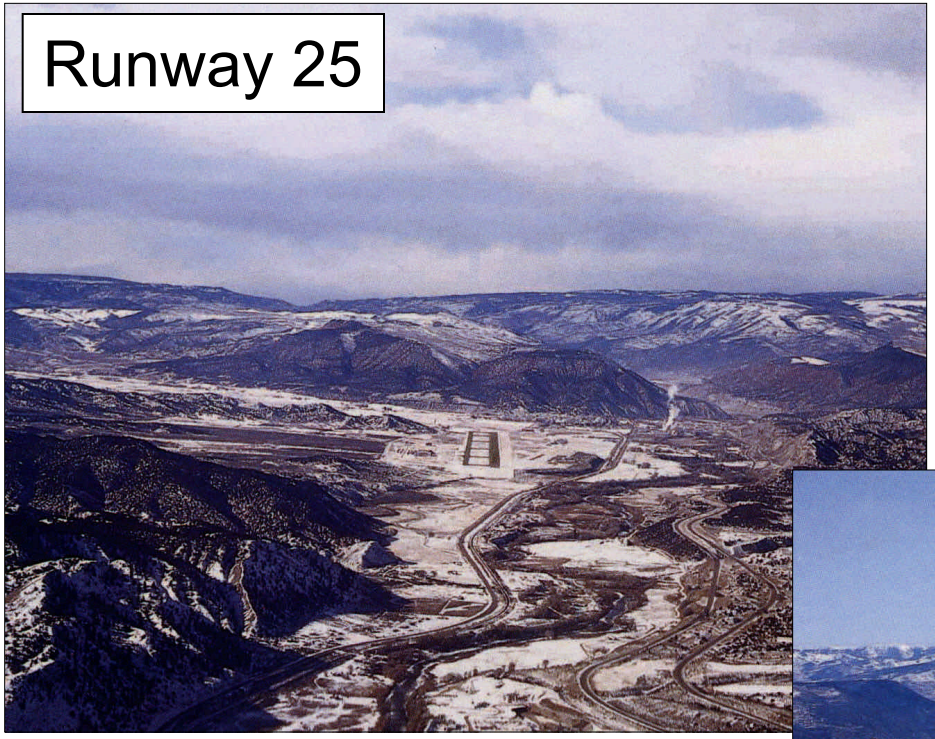
Summary

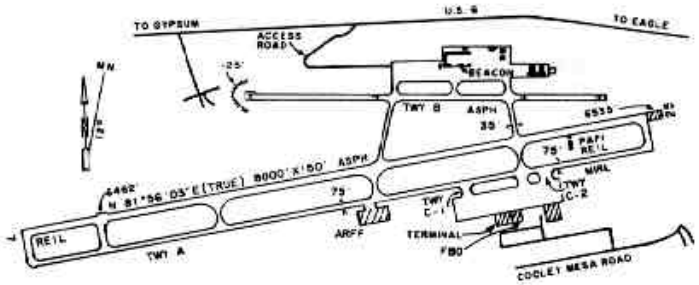
- NASA Opaque image on HUD appears viable for retrofit (at least for night operations)
- Synthetic vision appears to be effective on all display types evaluated (Size-A/B, D, X, and HUD)

TYPE	RETROFIT APPROACH
Mechanical cockpits	HUD
Glass cockpits	Existing displays (size-A/B, D)
Future cockpits	New larger displays (size-X)

- Rockwell-Collins concept considered effective & fairly mature
- All pilots preferred availability of multiple FOV selection
- All pilots acknowledged the enhanced situational awareness provided by synthetic vision, regardless of the SVDC size/type

Next: Eagle/Vail





The other terrain extreme from DFW:

- Terrain-sensitive area
- Compare with DFW results
- Investigate using synthetic vision to improve navigation performance and reduce Min Descent Alt. (MDA)
- Include Terrain Awareness and Warning System (TAWS) in evaluations

For More Information…Contact us:

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SVS Website: http://avsp.larc.nasa.gov/Pages/AvSPsyntheticvision.html

"You should be very proud of the work you're doing… it's really cool!" *A Departing Evaluation Pilot*